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# Pressure-Promoted Relaxation: Access to Forbidden Glassy States

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**Abstract:** The structure and properties of glass can be modified through compression near the glass transition temperature ( $T_g$ ), but once the compressed glass undergoes annealing near  $T_g$  at ambient pressure, the modified structure and properties will relax. First, we show how the property relaxation is correlated with both the local and the medium-range structural relaxation in a sodium borate glass that has first been compressed at its  $T_g$  at 1 GPa, and then annealed at ambient pressure under different temperature-time conditions. The pressure-induced structural conversions are reversible during ambient pressure annealing near  $T_g$ , but exhibit a dependence on the annealing temperature. However, the conversions between structural units cannot account for the pressure-induced densification, and instead we suggest the packing of structural units as the main densification mechanism. Second, we also show that by first compressing an aluminosilicate glass at 1 GPa at  $T_g$ , followed by sub- $T_g$  annealing *in situ* at 1 GPa, it is possible to combine the effects of hot compression and ambient pressure annealing. Through density, hardness, and heat capacity measurements, we demonstrate that the effects of hot compression and sub- $T_g$  annealing can be combined to access a “forbidden glass” regime of high density and hardness that is inaccessible through thermal history or pressure history variation alone.